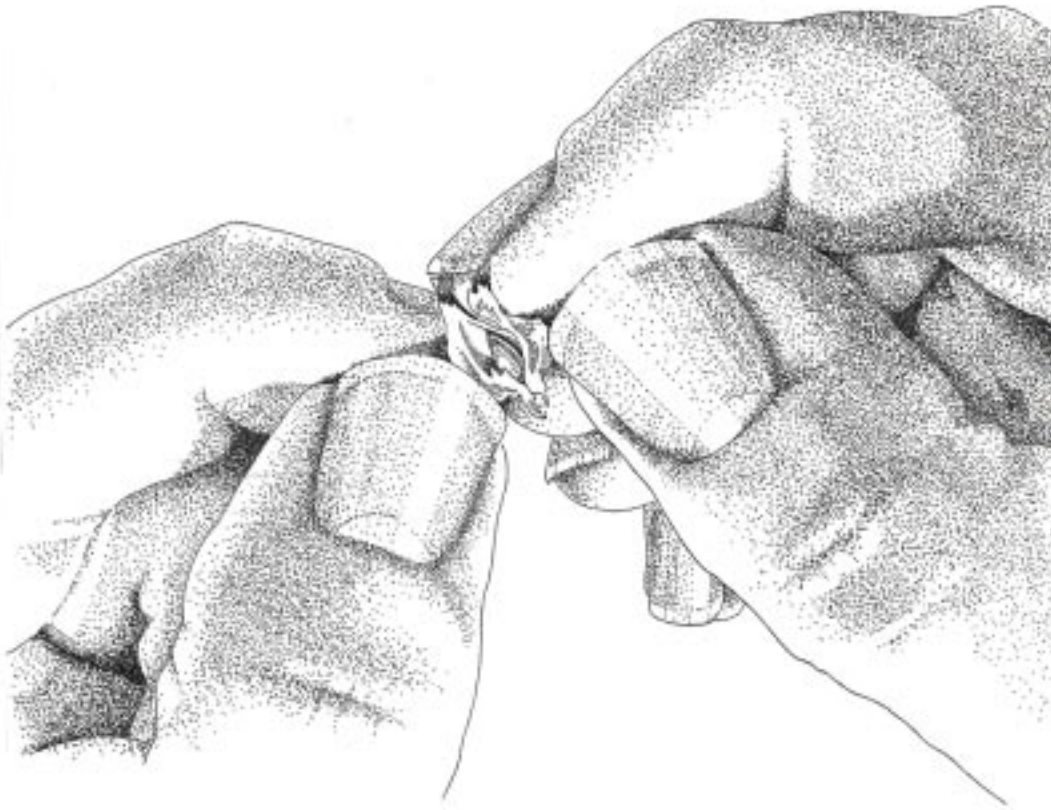


SECTION 4

GROWING PLANTS FROM SEED



GROWING PLANTS FROM SEED

4.1 SOIL

Plants need a growing medium that provides physical support, water, air, and nutrients and is disease- and weed-free. Ideally, we would use native soil in the nurseries so the plants would not have to adjust to different soil when outplanted. However, most of our soil types will not grow healthy plants when used in a container. Why?

The soil throughout the park varies from sand to clay to gravel to serpentine and contains not only **sand, loam, silt, and clay**, but also **bacteria and fungi**. Some bacteria and fungi are beneficial, while others are **pathogenic** (disease-causing). Mature plants can usually resist these diseases; younger plants, with their thinner cell walls, often cannot.

At the Presidio and Fort Funston indigenous plant nurseries, many of the plants grown are native to the sand dunes, which contain virtually no nutrients. These plants

compensate for this poor **substrate** by growing vast root systems that spread great distances for water and nutrients. Dune plants hold the sand in place with this network of roots. When starting seed in a pot, we must provide more nutrients due to the small space the roots have to explore.

Clay soils have very tiny particles; they drain slowly and will hold a high column of water. The tiny spaces between particles act like capillary tubes, drawing the water in and holding it tightly to the clay particles. In the field, a “head” of water builds up and the weight of the column of water (the effect of gravity) pushes water down through the soil. In a pot, the height of the water is not enough to overcome the suction (negative pressure) of the tiny particles and the pot stays saturated. We therefore use a medium with larger particles so water is not held in the pot but can drain and allow air to reach the roots.

We use soil with particles the size of medium-to-large grains of sand, (1/25 to

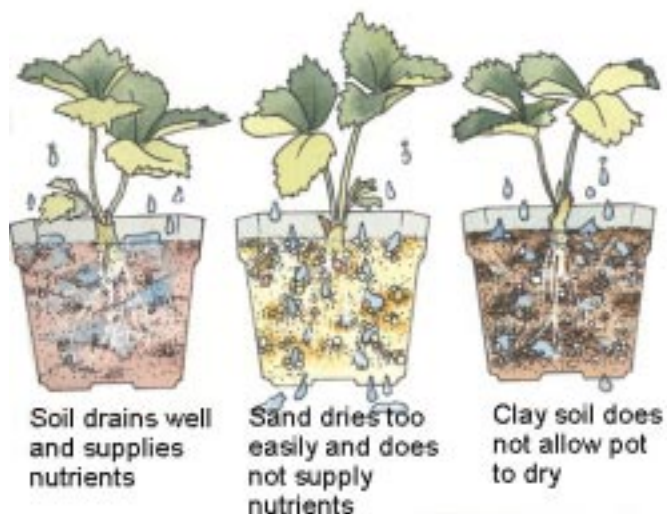


Figure 4.1. Soil types

1/12 inch) that are organic so they can provide not only good drainage but also hold nutrients for the plant. Organic matter contains organic polymers that bind clay, silt, and sand together. For example, it improves the drainage of a clay soil in the ground by gluing the tiny clay particles into larger, better-draining particles. In a pot or in the ground, organic matter provides lots of charged sites (**cation exchange capacity**), which hold charged nutrients like a magnet. Common nutrients (NO_3^- , PO_4^{3-} , NH_4^+ , Ca^{++} , Mg^{++} , K^+) can be held temporarily until needed by the plant.

Soil particles must be of uniform size. If there are large and small particles in the potting mix, the small particles will fill in the air spaces between the large particles and again, the mix will hold water in the pot. At least 20 percent of the volume in a pot needs to be air-filled for good growth and healthy plants.

We want a mix with the following qualities:

- Light, somewhat fluffy consistency, indicating that there is sufficient air in the mix.
- Moderate nutrient holding capacity.
- Good water retention.
- Good drainage (perhaps most impor-

tant, as indigenous plants are very vulnerable to disease in waterlogged soil).

The potting soil mix we create has these characteristics. It consists of fir bark ground to the proper size, peat moss, sand, Nutricote (a fertilizer, see Plant Nutrition section for details), and perlite. This is our basic mix and we use it for most plants (see following section, "Soil Mixing").

Because we outplant in the winter and use small containers, there is not a great problem with the difference between the native soil and the container mix. As there is little room in the original rootball for additional root growth, roots grow quickly out into the native soil once they're in the ground.

4.2 SOIL MIXING AND POT FILLING

Our regular potting mix is a special mixture of essential ingredients for starting plants. It is fairly clean, but if you step into the potting mix pile, you can contaminate it with a bad fungus. When we walk, we pick up microscopic fungi spores. We have

had problems with fungal diseases in some of our plants, probably due to poor sanitation practices. Be sure to sanitize shovels and wheelbarrows before mixing soil with these tools.

The soil recipe below is what we generally use, though sometimes, we make adjustments to our regular mix, adding sand for dune species or perlite for better drainage. We store extra soil in a covered yellow bin so it stays clean and moist.

Safety tips for shoveling

- Use the muscles in your upper legs to do the work.
- Bend at the hip and knee, never the waist.
- Try not to twist when shoveling. Back injuries most often happen when turning.

Soil Recipe for Oceana Plants

For 1 wheelbarrow of soil, mix 3 parts Sloat potting soil with 1 part perlite and 2 cups of Nutricote fertilizer (the gray pellets).

Supplies

Square-point shovel
Wheelbarrow
Dust mask
Measuring cup
Bag of Sloat potting soil
Bag of perlite
2 cups Nutricote

Procedure (Soil Mixing)

- Get supplies out of sheds.
- Clean the tools with water, bleach, and brushes, then rinse.
- Put on dust masks when using perlite.
- Add 3 shovelful of Sloat potting soil mix to the wheelbarrow and 1 shovelful of perlite.
- To minimize dust, moisten the perlite layer with a bit of water before mixing.
- Continue to make layers, 3 shovelful of soil to 1 of perlite, 3 more soil to 1 more

of perlite, etc. This will help the pile mix faster and more thoroughly.

- Add the Nutricote when you have a full wheelbarrow, or add a little with each layer.
- Using the square-point shovel or your hands, mix thoroughly until the soil mix is consistent throughout.
- Use the soil to fill pots (see following).
- Store extra soil in the yellow bin. Keep lid closed so mix retains some moisture. It is difficult to dampen after it has completely dried out.

Procedure (Pot Filling)

- Line up four racks of pots close together.
- Scoop mix into pots; be sure to fill the pots at the edges and corners of the rack. **Fill the pots to the brim.** Use the edge of the scoop to move the mix that piles up to the edges and corners.
- Give the pots a tap on the bench and refill to the top. **Don't use your hands to pack the mix down.** Smooth the soil level and fill any low spots.
- Alternatively, you can place one rack of pots atop the wheelbarrow full of soil and fill it right there, so the extra soil falls back into the wheelbarrow. **Remember to tap the racks so the soil settles and can be refilled to the top and smoothed before sowing.** We want fairly full pots so plants will have enough soil to develop good roots and thrive until they are ready to be outplanted in the rainy season.

4.3 SOWING IN TUBES OR POTS

Most herbaceous plants are sown from summer to early fall, the time in the field when seeds are naturally dispersing.

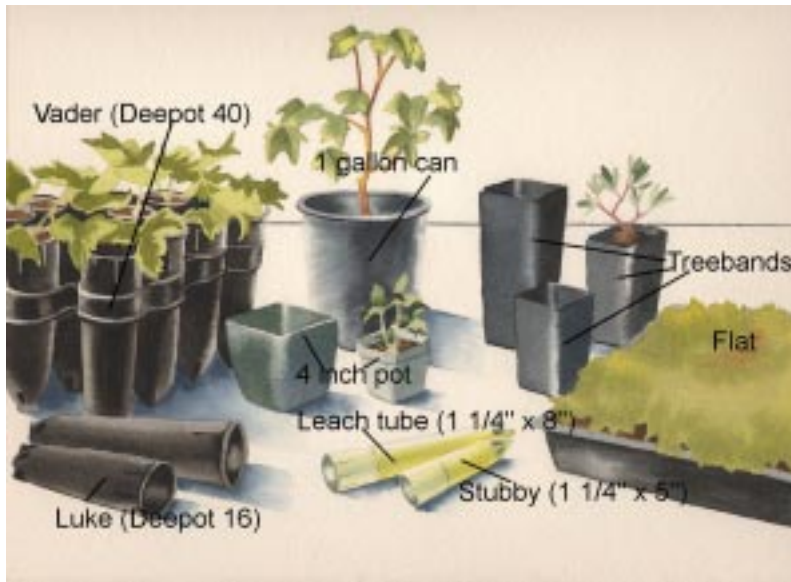


Figure 4.2 Various planting containers

Crops are timed to be ready to plant in the winter when rain waters the plants for us. This also gives the roots a chance to become established before the top of the plant begins to grow in the spring.

Then it's spring and time to sow. When the seeds are sown depends on how fast the species grows. Slow growers are planted earlier in the season, and fast growers, later. The size of the pot (tube) each species needs is also considered. Seeds are only sown on a **flat** if they are tiny or germinate poorly, or if we are experimenting. At Oceana we generally sow plants directly in tubes because the plants we grow are good germinators. This eliminates problems like kinked roots that have hit the bottom of a seed flat and damage when transplanting.

Because Milagra Ridge is a harsh, unirrigated site, we outplant pruned plants. This gives a high root-to-shoot ratio, one in which the roots are more developed and can bring up scarce water and nutrients to the above-ground part of the plant. A plant pulls up water in direct relation to the leaf surface area—the more leaves, the more water needed. The less leaf area, the less water needed. For most shrubs, we usually use

lukes and **vaders** (10-inch-deep pots) to encourage 10-inch-long root systems that grow straight down. The standard gallon can or pot is only 6 inches deep. Six-inch-deep roots cannot supply a large plant with the water it needs.

4.4 SOWING PROCEDURE

Supplies

Racks of clean tubes
Hose and fanhead nozzle
Seed
Small, shallow tray
Potting mix (soil)
Pencils
Labels
Propagation forms
Scale
Colander

Procedure

- Fill pots or tubes with the regular potting media (see "Soil Mixing" and "Pot Filling" sections for procedure).
- Gently water pots or racks of tubes with fanhead nozzle, which won't compact

the soil. You should see dark soil in the openings at the bottom of the tube, indicating that the soil is moist all the way through.

- Put rack on bench in front of you.
- Weigh the seeds you will be using so you can determine how much (by weight) seed you sowed when you are done.
- Put enough seed in a shallow tray for three to five seeds per tube.
- Put tray on top of rack or next to it.
- Work down the rows, one at a time, putting three to five seeds in each tube.
- Continue until each tube has seed.
- Cover the seed with a thin layer of extra potting mix, using a colander. Use only enough soil to barely cover the seeds. Covering too heavily is one of the main causes of poor germination.
- Make two labels for the rack, using a pencil (pen wears off with watering). Labels include: four-letter species code, date sown, and site where seed was collected.
- Using the fine spray nozzle on hose, gently water racks to settle soil and moisten seed.
- Place in greenhouse. Be sure mist is on the timer.
- Weigh remaining seed, calculate weight of seed used.
- Fill out propagation forms.

4.5 AFTERCARE OF NEW SEEDLINGS

Recently sown racks of pots need special attention. The soil surface and seed itself need to be kept moist so the seed can germinate and survive the initial period before roots are developed. If the seed

germinates and then dries out, it will die. Be sure the misting system in the greenhouse is keeping all pots moist throughout the day. This means frequent short misting (30 seconds to 1 minute, every 1/2 to 1 hour). Weather makes a big difference: if it's sunny and hot, the soil surface will dry much more quickly than if it's foggy and cold. This is why we do daily checks and regulate the heat in the greenhouse by venting, opening the door, and putting shade cloth over the greenhouse during the warm months when necessary.

With the exception of grasses, after germination, any extra seedlings in a pot are removed, leaving only one plant per pot. When we remove seedlings, we can transplant them into pots where none of the seeds germinated. We use simple tools like pencils and chopsticks to carefully remove extra seedlings and replant them in neighboring pots. We save a variety of seedlings, not just the biggest or the first to germinate; the variety enhances genetic diversity.

How do I know if my extra seedlings are ready to be transplanted into new pots?

Seedlings are ready to be transplanted when they have two sets of true leaves (four leaves) and appear to have a healthy root system.

Why do the seedlings look like they have two different types of leaves?

The lowest set of "leaves" that appear first are not actually leaves at all, they are **cotyledons**. There are either one or two cotyledons (grasses and all **monocots** have one; most other plants we grow are **dicots** and have two). These are the food storage structures that nourish the seed embryo until it grows the true leaves that produce their own food through photosynthesis. True leaves look different from the cotyledons and usually emerge in sets above them. Transplanting can be done

once there are two sets of true leaves.

Procedure (Thinning and Transplanting Seedlings)

The goal here is to remove the seedling with minimal damage to the tender new roots and to disturb remaining seedlings as little as possible.

- Carefully loosen soil around one seedling with chopstick, pencil, or other tool, and gently lift it out by holding the cotyledon. Try not to handle the true leaves.

- Dig a small hole in the center of one of the empty pots. Holding the seedling by a cotyledon (below the true leaves), lower it into the hole so that the roots hang freely. The surrounding soil should come to the same level on the seedling as it did in the seedling's previous pot, or right around the crown of the plant.

- Put the displaced soil back into the hole around the newly transplanted seedling. Be sure all the roots are covered.

- Once a rack of pots is completed, water it gently but completely until water runs out of the bottom of the pots.

4.6 FILLING A FLAT WITH SEED MEDIA

Sunshine Plug Mix is only used when we sow into flats. (We rarely sow seed in flats at Oceana. We usually use tubes—it's quicker and we lose fewer plants because we don't have to transplant all of them out of the flat and into pots.)

Supplies

Flats

Hose

Sink/tub

Bleach solution

Newspaper

Sunshine Plug Mix

#5 Scoop

Fan-head Nozzle

20- to 26-inch leveling stick, lath, or yardstick

Procedure

Cleaning the flats:

- Hose off loose dirt from inside the flats.

- Fill sink with enough water to submerge the flats you will be using.

- Put on rubber gloves and safety glasses.

- Add about 1 teaspoon bleach per gallon of water.

- Submerge the flats; let them soak at least thirty seconds.

- Rinse thoroughly with clear water.

Filling the flats:

- Fold a piece of newspaper, use it to line the bottom of flat.

- Moisten Sunshine Plug Mix in a sterilized wheelbarrow.

- Scoop out enough Sunshine Plug Mix to completely fill flat.

- With your hands, spread out the mix so all edges and corners are filled to the top.

- Use the edge of a leveling stick to level the flat mix. Using a zigzag motion across the flat works more smoothly. Watch for light under the stick; fill in these low spots.

- Discard any flat mix that falls on the bench or floor.

- Using a fan-head nozzle, gently water the flat (a properly watered 16 inch x 18 inch flat should weigh about 11 pounds.).

- Let the flat drain, and the flat is ready to sow.

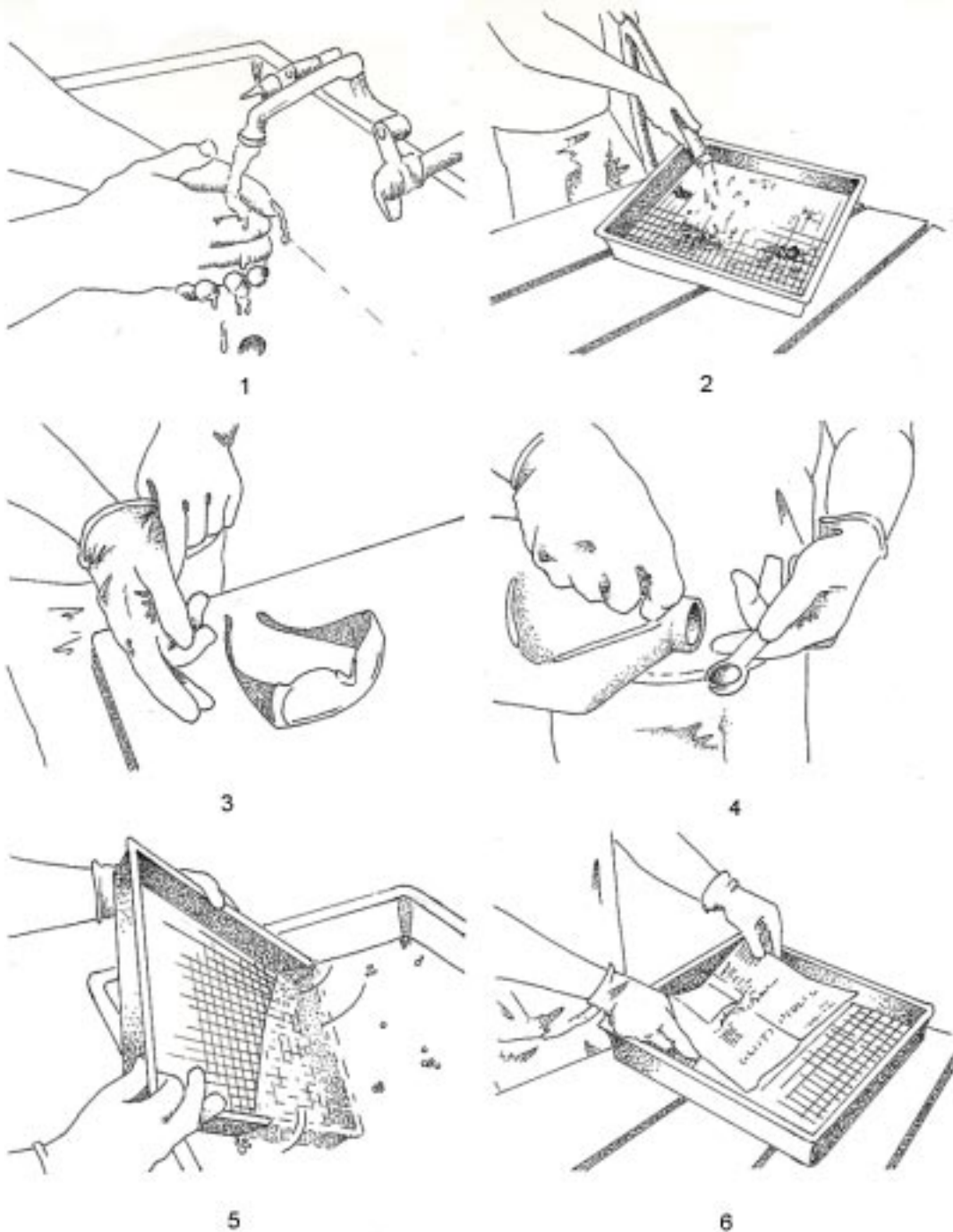


Figure 4.3 Cleaning a Flat

1. Wash hands and fill sink with enough water to submerge the flats.
2. Hose off loose dirt from inside the flats.
3. Put on rubber gloves and safety glasses.
4. Add about 1 teaspoon bleach per gallon of water.
5. Submerge the flats. Let them soak for at least thirty seconds. Rinse thoroughly with clean water.
6. Fold a piece of newspaper and use it to line the bottom of the flat

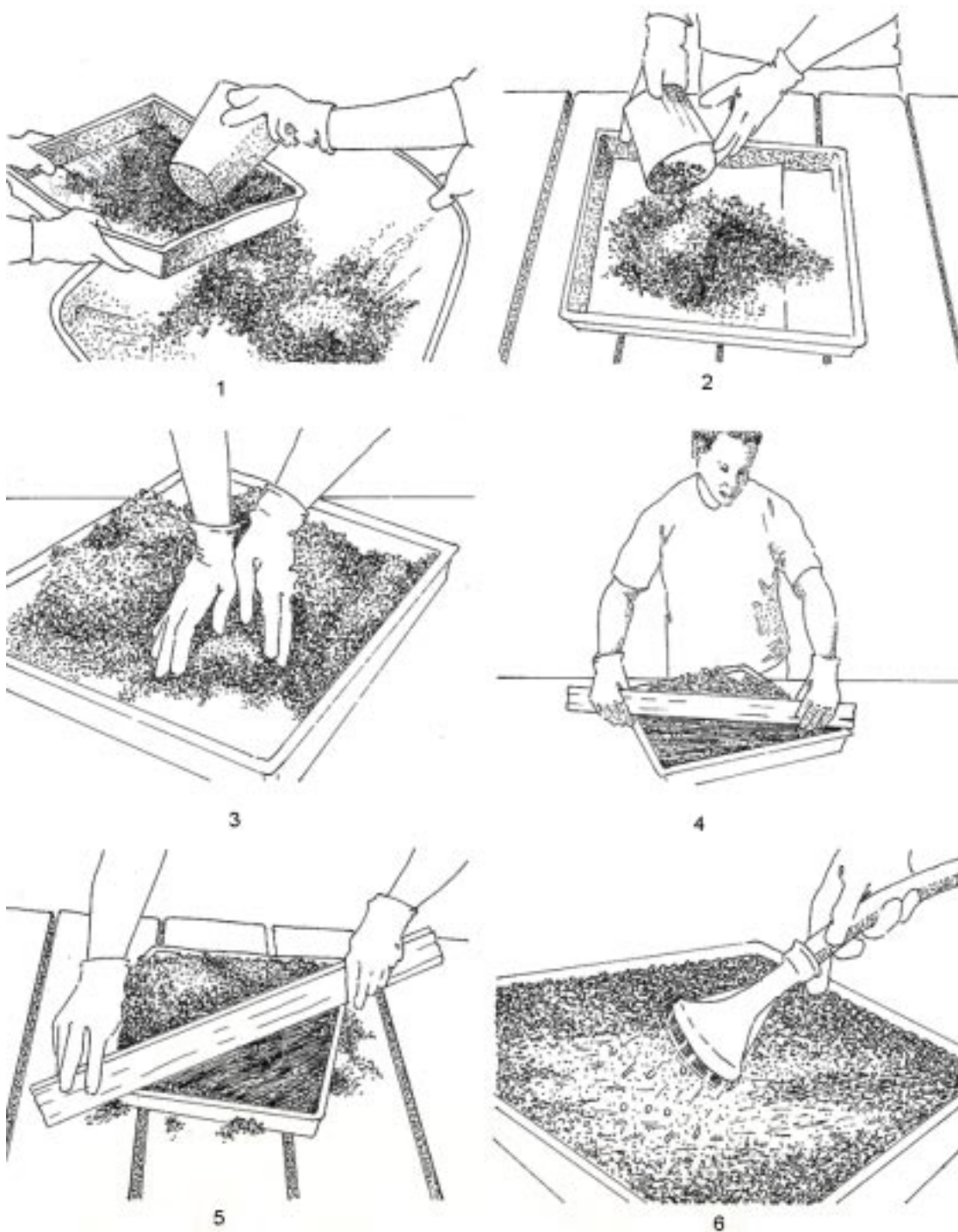


Figure 4.4 Filling the flat

- 1. Moisten Sunshine Plug Mix in a sterilized wheelbarrow*
- 2. Scoop out enough Sunshine Plug Mix to completely fill the flat.*
- 3. With your hands, spread out the mix so that all edges and corners are filled to the top.*
- 4. Use the edge of a leveling stick to level the flat mix.*
- 5. Using a zigzag motion across the flat works more smoothly. Watch for light under the stick and fill in those low spots. Discard any flat mix that falls on the bench or floor*
- 6. Using a fan-head nozzle, gently water the flat (a properly watered 16 inch x 18 inch flat should weigh about 11 pounds). Let the flat drain, and the flat is now ready to sow.*

4.7 SOWING SEED ON A FLAT

Supplies

Filled and moistened flat
Extra growing media
Small scoop to spread seed
Scale
Seed
Shallow pan to mix seed
Tamper (cement trowel works well)
Colander

Procedure

- Fill flats with growing media (to calculate how many flats you need, remember that no more than approximately 1,000 small or 500 large seeds should be sown per flat).
- Water flats and allow them to drain.
- Place filled, leveled, and moistened flat on bench.
- Weigh seed to be used so weight of seed sown can be calculated at the end of the day.
- Put enough seed for each flat in a shallow pan.
- Using the colander, sift some of the extra dry media over the seed in the pan.
- Mix seed and media evenly.
- Pour half of the seed mix in a small (1 cup) scoop.
- Sprinkle over flat.
- Give the flat a one-quarter (90 degree) turn.
- Pour the rest of the seed mix in the scoop and sprinkle in the other direction. This helps distribute the seed evenly.
- Don't cover the seed with media if the seed cannot be easily seen with the naked eye. If the seed is large enough to see, use the colander to sift media over the flat until the seed is covered completely and is no longer visible.
- Using the tamper, lightly press the seed into the media. Be sure each seed is in good contact with the media.

- Check to see that seed is still covered; if not, sift more media over flat.
- Label flat, using pencil. Include four-letter code, date sown, and site where seed was collected.
- Using the mist nozzle, gently water the seed. Hold nozzle at a right angle to the flat so spray is falling vertically and not at an angle. Otherwise, seed can be washed off the flat.
- Put flat in the greenhouse. Be sure mist system is functioning.
- When all flats are sown, weigh unused seed. Record weight of seed used and other required information on the propagation form.

4.8 TRANSPLANTING SEEDLINGS FROM FLAT TO POTS

How do I know if my seedlings are ready to be transplanted?

Seedlings are ready to be transplanted from flats to pots when they have two sets of true leaves (four leaves) and appear to have a healthy root system.

What size pot do I transplant into?

This depends on the species, but seedlings are generally transplanted from the flat to 2- to 4-inch pots, lugs or occasionally vaders. Strawberry plants go into 4-inch pots.

Why do the seedlings look like they have two different types of leaves?

The lower set of "leaves" that appear first are not actually leaves at all, they are cotyledons. There are either one or two cotyledons (grasses and all monocots have one; most other plants we grow are dicots and

have two). These are the food storage structures that nourish the seed embryo until it grows the true leaves that produce their own food through photosynthesis. The true leaves look different from the cotyledons and usually emerge in sets above the cotyledons. Transplanting can be done once there are two sets of true leaves.

Supplies

Flats of plants to be transplanted
Racks or flats of pots
Potting soil
Hose with misting nozzle
Plastic fork
Tags, pencils
Propagation and Transplant Record

Procedure

- Separate flats of different species on the work table.
- Fill appropriate-sized pots (in flats or racks) with potting soil.
- Dampen soil in pots if it is very dry.
- Study plants in the flat to be sure that they are all ready to be transplanted. If they are not all ready, let your crew know which ones are ready and why.
- Remove seedling from flat using a plastic fork. Create a circle around the seedling and scoop deeply beneath it. The

goal here is to remove the seedling with minimal damage to the tender new roots and to disturb nearby seedlings as little as possible.

- Dig a small pit in the center of one of the pots. Holding the seedling by a cotyledon (below the true leaves), lower it into the hole so that the roots hang freely. The surrounding soil should come to the same level on the seedling as it did in the flat, right around the crown of the plant.
- Put the displaced soil back into the hole around the newly transplanted seedling. Be sure all the roots are covered.
- If the roots on some seedlings are too long to hang freely when transplanted according to the above method, do the following: fill a pot one-third to one-half full of potting soil. Hold the plant by the cotyledon and lower into the pot.
- Fill the rest of the pot with soil while holding the seedling at the level you want. Be sure to fill in carefully but thoroughly around the roots.
- Once a flat or rack of pots is completed, water it gently but completely until water runs out of the bottom of the pots.
- Tag flats with appropriate information (add transplanting date to existing tags) and fill out propagation record.
- Place flats in greenhouse.



Figure 4.5 Transplanting seedlings